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Carbonea assimilis and *Rinodina aspersa,* new to Poland

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Abstract—Two saxicolous species of crustose lichens new to Poland, *Carbonea assimilis* and *Rinodina aspersa*, were recorded from the SW part of the country where there is an abundance of different rock formations, including natural outcrops of volcanic rocks. The characteristics of these species, as well as their ecology and geographical distribution, are provided and briefly discussed.

Key words—*Ascomycota, Lecanoraceae*, *Physciaceae*, taxonomy

Introduction

The lichen biota of Poland (now estimated at c. 1600 species; Fałtynowicz 2003) continues to be enlarged by newly reported taxa, most of which are corticolous, crustose, and especially sorediate lichens, the determination of which has been made possible through the use of thin layer chromatography or phylogenetic analysis (Kukwa & Kubiak 2007; Czarnota & al. 2009; Kukwa & Jabłońska 2009; Kukwa & al. 2012; Guzow-Krzemińska & al. 2016, 2018). Less frequently new records are foliose (Ossowska & al. 2014, Ossowska & Kukwa 2016) or saxicolous species (Wilk & Flakus 2006; Flakus 2007, 2014; Śliwa & Flakus 2011; Wilk 2011).

In this paper, new records of saxicolous species collected from natural outcrops of volcanic rock formations in SW Poland are presented. Volcanic rocks, including basalt rocks, are often habitats for rare lichens and consequently rare lichenicolous fungi (Kossowska 2000; Szczepańska 2012a, 2012b, 2015; Szczepańska & al. 2013) due to specific conditions, usually warm

and dry, as well as a substrate rich in minerals, such as calcium and magnesium compounds.

As the two presented species possess inconspicuous, crustose thalli that could be confused with similar taxa, their diagnostic features are provided as well as habitat requirements and distribution in Central Europe.

Materials & methods

Specimens were collected by the author in 2012 and 2013 during lichenological investigations of natural outcrops of volcanic rocks in the Polish Sudety Mountains. Descriptions of the species are based on the personal observations, measurements, and TLC analyses. The morphology of the species was studied with dissecting and light microscopes following routine techniques; for light microscopy, free-hand sections were made with a razor blade and mounted in water. Tissue measurements were made in water, and ascospore measurements in 10% KOH (K). The TLC analyses were performed in solvent systems A, B, and C, using the standardized method of Culberson (1972) and following Orange & al. (2001). Localities of the species are mapped according to the ATPOL grid square system (Zając 1978) modified by Cieśliński & Fałtynowicz (1993). Herbarium material is housed in the private herbaria of the author (Hb. Szczepańska), with duplicates donated to the Herbarium, Wroclaw University, Wroclaw, Poland (WRSL) and to the Herbarium, Gdansk University, Gdansk, Poland (UGDA).

The species

Carbonea assimilis (Hampe ex Körb.) Hafellner & Hertel,
Flecht. Baden-Württembergs, Verbreitungsatlas: 511, 1987. Fig. 1

Thallus lichenized, crustose, small and thin, areolate, forming irregular patches between other lichens thalli. Prothallus invisible. Areoles flat to slightly convex, 0.2–1.0 mm diam., angular, matte to glossy, olive-brown. Apothecia sessile, small, 0.1–0.3 mm diam., dispersed, rounded, proper margin persistent, glossy and rather thick, disc black, flat and glossy. Hymenium colourless, 40–50 µm tall, epithecium greenish-blue, hypothecium colourless, exciple thick, dark, brownish-black, paraphyses simple to slightly branched. Asci 8-spored, *Lecanora*-type with non-amyloid apical cushion, ocular chamber visible. Ascospores: hyaline, simple, ellipsoid, 8–10 × 5–6 µm.

Chemistry—No chemical substances were detected in the analyzed material.

Specimen examined—**POLAND, Sudety Mountains, Pogórze Zachodniosudeckie Foothills**, Ostrzyca Proboszczowicka hill, alt. 450 m, ATPOL grid square Eb-40, on basanite rocks, 26 Sept. 2012, K. Szczepańska 939 (Hb. Szczepańska; duplicate in WRSL).

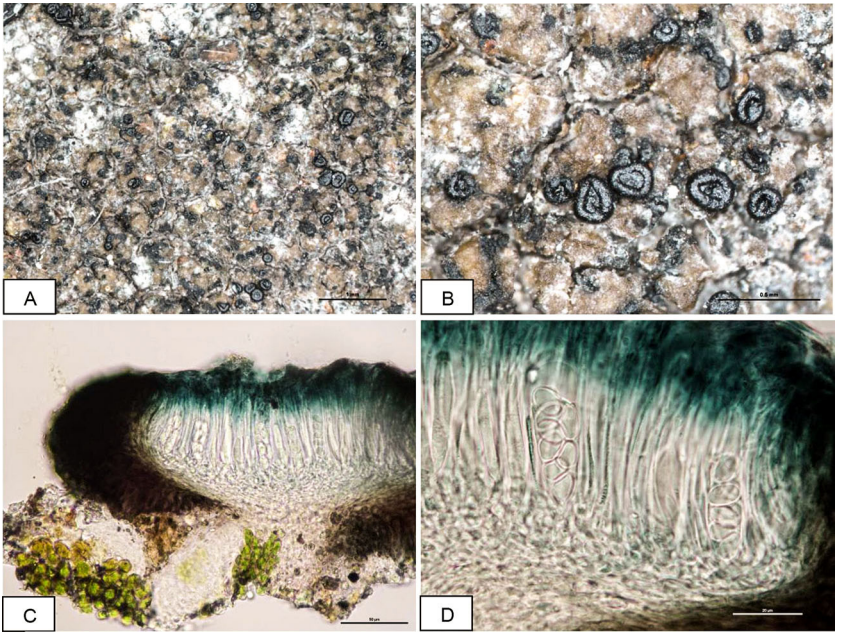

Fig. 1. *Carbonea assimilis* (WRSL – Szczepańska 939): A. thallus; B. apothecia; C. cross section through apothecium; D. ascospores in the ascus. Scale bars: A = 1 mm, B = 0.5 mm, C = 50 µm, D = 20 µm.

Ecology—The species is known as an obligate parasite of crustose lichens. It initially parasitizes various lichen taxa growing on siliceous rocks, such as *Aspicilia* spp., *Lecanora frustulosa, Lecidea lapicida, Pertusaria pseudocorallina, Rhizocarpon* spp., and *Tephromela atra*, before developing independent thalli (Andreev 2003, Hafellner 2006, Pirogov & al. 2014). Typical habitats for *Carbonea assimilis* are neutral to weakly basic, mineral-rich rocks (e.g. basalt, gneiss, and slate), in sunny and warm places, in mountain regions (Wirth 1995, Chambers & al. 2009).

The Polish locality of *Carbonea assimilis* was on a volcanic hill in SW Poland. The hill is one of the relics of ancient volcanic activity in this region, and during the last glaciation it was nunatak (free of ice) (Staffa 2002). In this locality *C. assimilis* was found in a non-parasitic state, growing directly on the rock in an exposed and insolated place. Associated lichen species included *Candelariella vitellina*, *Lecanora soralifera*, *Lecidea fuscoatra,* and *Xanthoparmelia loxodes*.

Distribution—*Carbonea assimilis* is considered a widely distributed but rare species, occurring in Europe, Asia, and North America (Andreev 2003). In Europe it has been found in Austria (Hafellner 1997), Czech Republic (Vězda & Liška 1999), Denmark (Søchting & Alstrup 2002), Germany (Wirth 1995), Britain (Smith & al. 2009), France (Roux 2012), Norway (Santesson & al. 2004), Portugal (Boom 1999), Romania (Costache & al. 2007), Spain (Llimona & Hladun 2001), Sweden (Santesson & al. 2004), and Ukraine (Pirogov & al. 2014).

Comments—The genus *Carbonea* (Hertel) Hertel, which was separated from *Lecidea* s. lat. by Hertel (1983), is represented by about 20 species of lichenized and lichenicolous fungi worldwide (Pirogov & al. 2014), of which five were previously known from Poland (Fałtynowicz 2003). Most of these species are exceedingly rare in the country, having scattered localities almost exclusively in the mountainous areas.

The Polish specimen of *Carbonea assimilis* presents this species' typical brown areolate thallus and very small black apothecia (Fig. 1A, B) with characteristic greenish-blue epithecium, dark exciple and colourless hypothecium (Fig. 1C). However, some small differences may be observed in the size of spores (Fig. 1D), which are shorter than cited in the literature data (see Chambers & al. 2009, Pirogov & al. 2014).

Carbonea assimilis can be confused with members of *Lecidella* Körb. Both *Carbonea* and *Lecidella* species usually have black apothecia with a lecideine margin, a blue-green epithecium and *Lecanora*-type asci. *Carbonea* differs mainly in its narrower spores and black true exciple, which in *Lecidella* species is usually pale within. Among *Carbonea* species developing independent, distinct thalli, *C. assimilis* may be confused primarily with *C. vorticosa* (Flörke) Hertel. However, *C. vorticosa* has a grey to whitish thallus, dark brown-black hypothecium, and narrower (4–5 µm diam.) ascospores and mainly grows in high montane regions (Pirogov & al. 2014).

Rinodina aspersa (Borrer) J.R. Laundon, Lichenologist 18: 175. 1986. Fig. 2

Thallus small, more or less circular, ≤13 mm diam., composed of aggregated or (more rarely) dispersed, areoles, delimited by a clearly visible, wide black prothallus, ≤0.2 mm. Areoles discrete, rounded to angular, slightly convex, pale to dark grey, matte. Soralia discrete, punctiform to circular, ≤0.3 mm diam., elevated, arising on the surface of the areoles, mainly in the centre of the thallus, concolorous with areoles or slightly grey-green

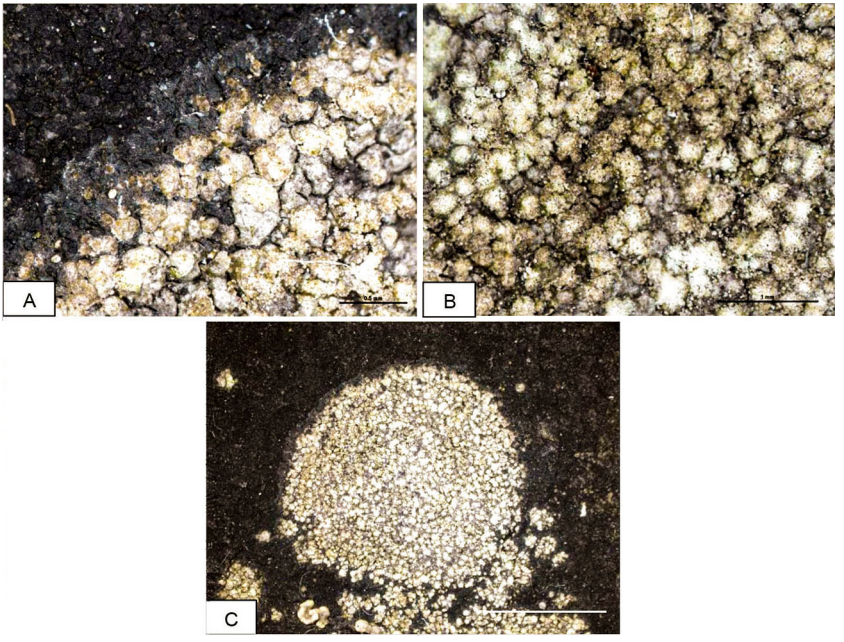

Fig. 2. *Rinodina aspersa* (WRSL – Szczepańska 941): A. prothallus. B. soralia; C. thallus. Scale bars: A = 0.5 mm, B = 1 mm, C = 5.0 mm.

in shaded places and dark-grey in more exposed habitats. Soredia farinose. Apothecia not observed in the studied material.

[Additional data from Mayrhofer & Moberg 2002: Apothecia very rare, ≤1 mm diam., lecanorine, disc brown to black, plane. Hymenium <100 µm tall, epihymenium brown, with fine granules. Hypothecium colourless. Ascospores 15–20 × 13–20 µm, *Pachysporaria*-type.]

Chemistry—*Rinodina aspersa* contains atranorin in the cortex (K+ yellow) and additional substances in the medulla, such as gyrophoric (C+ red; usually accompanied by lecanoric and orsellinic acids), umbilicaric, ovoic, and 5-O-methylhiascic acids (Mayrhofer & Moberg 2002). Substances detected in the Polish specimens are consistent with the literature data.

Specimen examined—**POLAND, Sudety Mountains, Góry Kamienne Mts**, Krucza Skała Mt., alt c. 680 m, ATPOL grid square Eb-91, on volcanic rocks - porphyries, 17 Sept. 2012, K. Szczepańska 941 (Hb. K. Szczepańska; duplicates in UGDA-L and WRSL).

Ecology—Typical habitats of *R. aspersa* in lichenological literature mention humid, foggy, and shaded places (Mayrhofer & Moberg 2002, Motiejūnaitė

& Grochowski 2014), including coastal sites (Giralt & Barbero 1995, Wirth 1995, Giavarini & al. 2009, Sheard 2010). Lime-free, hard silicate rocks (such as basalt, flint, gneiss, granite, shale, and rhyolite) are mentioned as substrata for this species. Very rarely *R. aspersa* has been noted in well-lit or sunny habitats (Vondrák & al. 2006) or on anthropogenic substrata, such as granitic megalithic monuments (Giralt & al. 1997).

The Polish locality of *Rinodina aspersa* lies in SW Poland on the rocky outcrops of a small mountain. Numerous *R. aspersa* thalli were observed on rocks and on stones forming a scree. Associated lichens were *Acarospora fuscata, Amandinea punctata, Aspicilia cinerea,* and *Lecanora polytropa*. Habitat conditions here are rather specific, with high insolation and low moisture of the substrates. This newly reported record of *Rinodina aspersa* may indicate a wider ecological spectrum, including not only shaded and humid habitats, but also warm, sunny and dry ones.

Distribution—*Rinodina aspersa* is considered a rare species, distributed from temperate Europe to south Portugal and the Mediterranean islands. It is found in the Czech Republic (Vězda & Liška 1999) Denmark (Søchting & Alstrup 2002), Finland (Vitikainen 1997), France (Mayrhofer & Moberg 2002, Roux 2012), Germany (Wirth 1995), Italy (Mayrhofer & Moberg 2002), Lithuania (Motiejūnaitė & Grochowski 2014), Montenegro (Knezevic & Mayrhofer 2009), Netherlands (Aptroot & al. 1999), Portugal (Giralt & Barbero 1995), Spain (Llimona & Hladun 2001), Sweden (Santesson & al. 2004), and U.K. (Smith & al. 2009). It has also been reported from North America (Glew 1999) and Taiwan (Aptroot & Sparrius 2003).

Comments—*Rinodina* (Ach.) Gray is represented by c. 200 species (Giavarini & al. 2009), of which c. 30 are known in Poland (Fałtynowicz 2003). *Rinodina aspersa* adds a fifth sorediate *Rinodina* species to the four previously recorded from Poland (Czarnota & Kukwa 2007, Kukwa & Kubiak 2007). However, unlike the other four species, which are epiphytic, *R. aspersa* occurs only on rocky substrates. In comparison with the other *Rinodina* species noted in Poland, it can be distinguished by its thallus chemistry, especially by the presence of gyrophoric acid, which is absent in other sorediate *Rinodina* species. The chemistry of the thallus and the occurrence of soralia are the most significant characters allowing one to differentiate *R. aspersa* from other species of *Rinodina*. All of the morphological features, as well as the chemistry of the Polish specimen are typical for this taxon and consistent with the descriptions given in the literature (Giralt & al. 1997, Giavarini & al. 2009, Sheard 2010).

Due to the presence of gyrophoric acid in the thallus and soralia (C+ red), *R. aspersa* may be confused with the saxicolous species of *Trapelia* M. Choisy, especially *T. obtegens* that additionally possess a similar thallus composed of scattered, convex areoles. The features that allow one to distinguish the two taxa are the clearly visible, black prothallus (Fig. 2A), discrete soralia (Fig. 2B), and more or less circular thallus of *Rinodina aspersa* (Fig. 2C).

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